Chapter 2. Make Do and Mend

How researchers used old collections in new medicine

18 July 1819. Dusk. Leiden professor Sebald Justinus Brugmans had been working all day in the botanical garden and the natural history cabinet. Suddenly, his chest hurt and his stomach cramped. At first, a simple blood-letting seemed to solve the problem. But the stomach cramps soon returned, and soon grew worse. Gastroenteritis, the diagnosis said, followed by gangrene. Four days after he had felt the first pain, the professor died.[1] He was survived by the roughly four thousand anatomical preparations he had acquired during his lifetime.

Brugmans' death marked the beginning of his collection's life in print. Brugmans used his preparations primarily during his classes: just like his contemporaries, he valued teaching more than research.[2] Of course, research was done, but the results were often communicated solely through teaching – 'publish or perish' was a phrase yet to be coined. Medical historian Antonie Luyendijk-Elshout extensively studied the eighteenth-century Leiden anatomical collections, but she found not a single publication in which Brugmans mentioned his collection. From this she concluded, 'To Brugmans, these preparations have probably seldom served for detailed study.'[3] Maybe to Brugmans the preparations indeed didn't, but to his successors, they certainly did. Nineteenth-century researchers regularly used the Brugmans collection in their publications, as this chapter will show. They also used the collections of Johannes Rau, Bernhard Siegfried Albinus and Andreas Bonn – all anatomists who lived and worked decades before the researchers discussed in this chapter.

The nineteenth-century researchers relied primarily on the old, mostly early modern collections. In 1850, the Anatomical Cabinet housed approximately 8000 preparations, of which around 7500 had been created before 1815.[4] New preparations were added, but the

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[1] Sandifort 1827, xxiv
[2] Theunissen 2000, 42
[3] Elshout 1952, 107
[4] These numbers are rough estimates because no complete catalogues or inventories were kept. I have based the number of 8000 on the four volumes of the main catalogue *Museum Anatomicum* (7382 preparations, all made before 1815) and an estimate of the amount of preparations acquired in the first half of the nineteenth century. In addition to the Brugmans and the Bonn collection (both catalogued in the *Museum*), three major collections were acquired: Jacobus Rocquette's (doctor and lecturer in Haarlem; collection acquired in 1818); Ledeboer's (first name and occupation unkown; collection acquired before 1827); and, in 1837, Simon du Pui's (Leiden professor). Du Pui's collection contained 76 preparations (Elshout 1952, 24–25). The sizes of the other two collections are unkown. Gerard Sandifort considers them less important than the Brugmans and Bonn collections (Sandifort 1827, Praefatio, 3–4), which suggests they were smaller. Therefore, I've estimated them to contain a few hundreds of preparations. The annual reports regularly mention individual preparations being added to the collections; in my estimate, 250 in total. Note that my numbers might be too high because some preparations are listed twice in the *Museum* (though other descriptions probably included multiple preparations) and because part of the preparations described in the *Museum*'s first two volumes were destroyed by an explosion in 1807. However, even if the numbers should be lower, my claim that most of the preparations were made before 1815 still holds true.

majority of these came from estates, meaning even many 'new' acquisitions were made by anatomists from earlier generations. Some researchers had private collections, but they usually added preparations to these collections with an eye on teaching, not research, as teaching was the main source of income for most researchers. Furthermore, these were small compared to the university collections. For most of their collection use, Leiden researchers had to make do with collections created by their predecessors, as had many other nineteenth-century researchers.[5]

This required some mending, for nineteenth-century medical research differed profoundly from its eighteenth-century predecessor. It entailed new disciplines, such as comparative anatomy, pathological anatomy, and developmental embryology.[6] Also, the old disciplines of anatomy and physiology transformed completely.[7] The emerging and changing disciplines used different spaces, like the laboratory and the clinic; different methods, like microscopy; and different concepts, like the cell.[8] All of these changes reached Leiden as well, although often later than they reached many other places.[9] None of the changes did away with the need for collections, but all of them put new demands on the collections. And yet, old collections continued to be used in the new medicine.

Apparently, the same preparations could be used in research for a long time. This chapter analyses the nineteenth-century afterlife of the Brugmans collection to understand how this prolonged use was (and still is) possible. To do so, we must first grasp how anatomical preparations functioned in medical research. It is tempting – and not unusual – to view preparations as end products in the making of knowledge. A preparation then displays a fact about the human body. Its role is to communicate that fact and to back up an anatomist's statement of that fact. Preparations can indeed function like this, but it is not their only use. The previous chapter demonstrated that preparations were not as static as they may seem nowadays: they were dynamic objects that moved around and were handled outside their jars. Nineteenth-century students handled preparations to learn anatomy, train their senses and get used to working with dead bodies. Nineteenth-century researchers handled preparations to produce knowledge. (As we have seen, in the second half of the nineteenth century doctoral students sometimes handled preparations in this way as well –

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[5] At the other Dutch universities, the situation was similar to the one in Leiden: nineteenth-century Utrecht researchers used the preparations of Jan Bleuland (1756–1838); in Groningen, researchers relied on the collection of Petrus Camper (1722–1789). Outside the Netherlands, institutional collections were often built around former private collections (see for example Alberti 2005b on British collections); these private collections had regularly been created in the eighteenth-century. Of course, new preparations were created as well – at the Royal College of Surgeons in London, for example, thousands of preparations were produced in-house during the nineteenth century. In Leiden, however, this was not the case: annual reports show that usually, less than ten freshly made preparations were added to the collections.

[6] On comparative anatomy see Nyhart 1995. On pathological anatomy see Maulitz 2002. On embryology see Hopwood 2009.

[7] Cunningham 2002, 2003

[8] On the rise of the laboratory in medicine, see Cunningham and Williams 1992. On the birth of the clinic, see Ackerknecht 1967 and Foucault 1976. On the growing importance of microscopy see Schickore 2007. On the construction of cell theory see Harris 1999.

[9] Beukers 1983, 1984

they wandered in that grey area between student and researcher.) In their handling, researchers reinterpreted and even redissected older preparations. It is therefore misleading to view preparations as end products alone. They were never finished; they were used not just to *display*, but also to *produce* knowledge. However, it would be equally misleading to view them as instruments or as unfinished raw materials – this would ignore their use as evidence, as communicative devices. In the act of research, preparations played a peculiar double role. They were both finished and unfinished; a representation of ready-made knowledge and raw material for new facts; and, if you want, artefacts and naturalia.

I use the work of Hans-Jörg Rheinberger, historian and philosopher of the biological sciences, to understand the double role preparations play in research. Rheinberger's analytic arsenal will not only be part of this chapter, but will also return in later chapters. I will therefore discuss Rheinberger's ideas on anatomical preparations in some detail in the first section of this chapter. Afterwards, I will sketch the background of the Brugmans collection and explain how it ended up in the Anatomical Cabinet. I will then demonstrate how nineteenth-century researchers (re)used Brugmans' preparations in various fields of study: physical anthropology, pathological anatomy, and, to conclude, comparative anatomy.

Preparations: made of what they represent

A preparation can be understood as a stabilized version of a (no longer) living thing and as such, it belongs to what Rheinberger calls 'epistemologica': 'material things rendered permanent in various ways that play a part in knowledge production by enabling facts to be exposed and elucidated.'[10] Here, we see the first of the preparation's two roles: the preparation as an end product, as a demonstration of a fact. Other types of epistemologica, like anatomical models, graphs and drawings, can also demonstrate facts.[11] Yet preparations also play a second role, one that is much harder to take on for other epistemologica: they can be used to produce new facts, instead of demonstrating existing ones. To understand why preparations can be used in this way, and why other epistemologica cannot (or only to a very limited extent), it is useful to compare anatomical preparations with anatomical models.

Models and preparations are similar in that they both *represent* a particular object of inquiry. Yet they are also fundamentally different because preparations are a very peculiar kind of representation. Rheinberger argues that 'normal' representations have two defining characteristics.[12] The first is a change to a different medium: an anatomical model is made of wax, papier-mâché or plastic, while its object is made of human tissue. The second is a rule (or set of rules) that maps the object to the medium. Preparations are atypical because

[10] Rheinberger 2010, 233–234

[11] Rheinberger does not explicitly state that graphs and drawings are epistemologica (he does for models, see e.g. Rheinberger 2010, 234), but I understand them as such.

[12] Rheinberger 2003, 9–10. Rheinberger uses philosopher of science Bas van Fraassen's definition of representation in his argument.

they lack the first characteristic. Although they are representations, they are not made of a different material than their objects. A kidney preparation does not, like a model, consist of wax or papier-mâché – it consists of *kidney*. Preparations are *made of what they represent*, which is what enables them to take on their second role: that of an unfinished product, empirical material, used to answer questions other than those they were made to answer.

Rheinberger refers to this capacity when he writes: 'the essence of organic preparations qua knowledge objects resides in this material complicity [being made of what they represent], which ensures their duration and the permanent possibility of their epistemic recall.'[13] Rheinberger's observation is crucial because it pinpoints *why* the Brugmans preparations could be reused again and again. This might not be immediately clear because, unfortunately, the observation is also rather dense. But think about what it takes for seemingly finished made-objects to be reused in producing new knowledge as happened to the Brugmans preparations in the nineteenth century. Most of all, they need to enable reinterpretations. Both preparations and models are created with certain questions, or at least vague ideas, in mind. Their makers create them to generate new knowledge relating to these questions or ideas (or, in the case of preparations intended solely for teaching, to demonstrate known facts). But as time goes by, (new) researchers start working with different questions and different ideas. For example, instead of wanting to describe a tumour macroscopically, they want to understand it on a cellular level. To answer the new questions, they need to either make new preparations and models, or reinterpret the old ones. Sometimes, a reinterpretation is as easy as writing a new label – when renaming a species, or reclassifying a plant, for example. But often, a reinterpretation is more complex and requires new empirical data: extra information that is not directly offered by the object. Take the tumour-example: a cell-theory related reinterpretation requires the tumour's microscopic structure, but neither a macroscopic preparation nor a macroscopic model represents this structure.

When it comes to such complex reinterpretations, preparations have an advantage over models: they are more likely to contain the required information because they are made of what they represent. Both models and preparations contain information, and both may contain more information than strictly required for the purpose they were made for. But models only contain information *added* by the modeller, while preparations contain all information *not taken away* by the prosector. Therefore, models only contain information that was accessible to their maker. For example, nineteenth-century papier-mâché models of snails *never* contain the snail's DNA structure because the molecular level was inaccessible to the dissecting and model-making instruments of the day. A nineteenth-century alcohol preparation of the same snail, on the other hand, *does* contain its DNA structure. The preparation maker did not have access to it, but he did not need to: the structure was nevertheless included in his material. Therefore, with the preparation it is possible to 'go

[13] Rheinberger 2010, 238

back' to the 'original' object of inquiry (the snail) and extract the DNA structure at a later date. None of this is to say that reinterpreting models is impossible; it only is much harder.

The 'going back' to the object of inquiry is what Rheinberger calls 'epistemic recall'. Rheinberger proves his epistemic recall in theory; using the example of the Brugmans collection, I will demonstrate how it worked in practice. For it was the continuous reinterpretation of preparations that kept Brugmans' collection useful for medical research throughout the nineteenth century.

Brugmans and his collection

Sebald Justinus Brugmans (1763–1819) collected his first naturalia in his parents' backyard, which he explored for shells and stones as a child.[14] He continued building collections for the rest of his life. When he studied in Groningen, he collected stones in areas surrounding the city; this collection formed the empirical foundation of his first doctoral dissertation, in philosophy, which he completed in 1781.[15] For his second doctorate, in medicine, he studied several years in Leiden. During that period, he assisted Leiden professor Dionysius van de Wijnpersse in ordering the natural history collection of the deceased medical professor Wouter van Doeveren (1730–1783).[16] Brugmans received his medical degree in 1785 from the University of Groningen.[17] Soon after, he was appointed professor in Franeker. He left a few months later, after having been offered a position in Leiden. The Leiden governors appointed him as a professor at the philosophy faculty, where he taught courses on botany, mineralogy and zoology. However, Brugmans was not satisfied with this position and longed for a professorship in the medical faculty. After some lobbying, he succeeded in 1791. This displeased the other medical professors, who feared they would loose students, and hence money, to Brugmans.[18] Brugmans' teaching was widely praised; he was said to speak appealingly and without notes. To illustrate his lectures, he built a collection of anatomical preparations – the same collection we will follow in this chapter.[19]

Brugmans remained a professor in Leiden until his death in 1819, but he regularly took on activities outside the university as well. He advised subsequent governments of very different political leanings on health issues. He led the national Military Medical Services for twenty years; advised on cattle plague; and contributed to a national pharmacopoeia,

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[14] Biographical information on Brugmans can be found in the many obituaries that appeared after his death, partly listed in Wallé 2007, 130–131. Most extensive are the ones by H. C. van der Boon Mesch and Abraham Capadose, written after a prize essay competition organized by the Holland Society of Sciences. (Van der Boon Mesch 1825; Capadose 1825) For a more recent interpretation of Brugmans' life, see De Jonge 1999 and De Jonge 2001. Brugmans' correspondence has been described in Van Heiningen 2008.

[15] Brugmans 1781

[16] Sandifort 1827, xiii

[17] Brugmans 1785

[18] De Jonge 1999, 10

[19] The collection is catalogued in Sandifort 1827 – more on that below. For a list of visitor reports and other literature on Brugmans' collection, see Engel et al. 1986, 46. Also useful is the description by Cornelis van der Klaauw: Van der Klaauw 1930.

the *Pharmacopoea Batava*.[20] His work on the battlefields and in military hospitals offered him ample opportunities to collect pathologies and foreign skulls. Possible sources for his animal preparations included the animals he dissected during his research on the cattle plague as well as the animals kept in the university's botanical garden.[21] Furthermore, several of Brugmans' relations – including Georges Cuvier, but also his subordinates in the Military Medical Services – sent him skulls, bones, fossils and other objects, sometimes fully prepared.[22]

In 1817, Brugmans offered his collection to the university, 'on the reasonable condition of compensation'.[23] The immediate cause for Brugmans' offer – and for the university governors' acceptance – was the 1815 Decree on Higher Education, which obliged all universities to own several types of anatomical preparations.[24] Among these were comparative anatomy preparations, which were lacking in the Leiden University collections but well represented in Brugmans' collection. Around half (2093) of Brugmans' 4081 preparations were comparative anatomical; just over a fourth (1154) were pathological; the remaining ones were mainly natural history objects (635) and fossils (141).[25] Because of the large number of comparative-anatomical preparations, the governors were keen on acquiring the collection. They agreed with Brugmans on a 'compensation' of thirty thousand guilders to be paid in six annual installments.[26] However, Brugmans died two years into the agreement, Brugmans, which prompted his widow to reopen the negotiations. She secured an additional four thousand guilders for herself, because of the new preparations made by Brugmans that had not been included in the first deal, and because she also offered the collection cupboards to the university.[27] In November 1819, the university officially owned Brugmans' collection.

The governors appointed Gerard Sandifort, curator of the Anatomical Cabinet, as supervisor of the Brugmans collection and asked him to catalogue it.[28] Sandifort replied with caution: he admitted that a catalogue would enlarge the collection's value, but explained that cataloguing would be difficult and time consuming.[29] He was willing to invest the required time, but asked for two things in return. First, he wanted to keep teaching the

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[20] Brugmans et al. 1805

[21] Van der Klaauw 1930, 50–51

[22] De Jonge 1999, 46. Sandifort 1827 sometimes names donors in the descriptions, but mostly he keeps silent about the objects' provenance.

[23] Brugmans to governors, 4 April 1817, AC2 70, 56

[24] RDHE 1815, art. 177

[25] Of course, the numbers depend on how you divide the different preparations into categories. I've taken the numbers from Van der Klaauw 1930, which is based on Sandifort 1827. Note that the pathological preparations contain a lot of animal preparations as well. Also, the comparative-anatomical preparations include foreign (human) skulls, which could equally be considered as a separate category.

[26] Minutes governors, 22 May 1817, AC2 3, fo. 87^{V}

[27] C. M. van Dam (widow to Sebald Brugmans) to governors, 14 October 1819, AC2 72, 131; Minutes governors, 25 October 1819, AC2 5, fo. 197; Minister of Education to governors, 6 November 1819, AC2 72, 141

[28] Minutes governors, 27 November 1819, AC2 5, fo. 211^{r}

[29] Sandifort to governors, 2 December 1819, AC2 72, 149

comparative anatomy classes; second, he wanted the comparative anatomy part of the collection housed within the Anatomical Cabinet. It went without saying that preparations of general and pathological anatomy would be added to the Cabinet, but the preparations of comparative anatomy would be useful in the university's natural history cabinet as well. Sandifort admitted this, but he claimed that they were better suited to the Anatomical Cabinet because of their ultimate aim of illustrating the structure and functions of the human body. When the governors ultimately decided on the fate of the comparative anatomy preparations in the Brugmans collection on 30 September 1820,[30] Sandifort had already finished half the catalogue, which consisted of descriptions based on Brugmans' labels and Sandifort's own investigations.[31] The governors allowed him to keep all comparative anatomy preparations, as he wanted, but decided that the natural history preparations were to be housed in the new National Museum for Natural History, into which the university's natural history cabinet had been incorporated.

Obviously, the new museum collected natural history objects, but what exactly are these? And how do they differ from comparative anatomy objects? A letter by Sandifort helps answer these questions. On 21 October 1820, he wrote the governors about the Brugmans preparations he intended to transport to the Museum for Natural History:

> Since Your Highly-Learned Dignitaries demand that all objects that do not directly belong to the collection of comparative anatomy, but are more related to natural history, are added to the Cabinet of Natural History, I will not fail to deliver to this Cabinet all objects kept in liquor, including the collection of shellfish, as instructive as extensive, &c.; the dried or stuffed animals; all fossil bones; and, further, one specimen of every skeleton and animal head we have in duplicate; I hope this meets your intentions.[32]

To Sandifort, natural history objects were whole-body preparations of animals (either stuffed, dried or in fluid), animal bones and skeletons, and fossils. Sandifort's definition matches the one found in a Ministerial Decree issued two months later, on what the Museum for Natural History should and should not collect:

> 2. In this museum, animal species (with the exception of man) and their complete or partial skeletons will be brought together and kept, and, further, fossils and minerals.
>
> 3. No preparations of the individual animal organs, neither pathological nor physiological, belong to the scope of this Cabinet.[33]

The museum was allowed to collect complete animals, animal skeletons, fossils and minerals; these were considered to fall under the header of natural history. Preparations of animal organs, however, were not added to the museum, as they were not considered to

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[30] Minutes governors, 30 September 1820, AC2 6, fo. 80
[31] Sandifort to governors, 29 September 1820, AC2 73, 124
[32] Sandifort to governors, 21 October 1820, AC2 73, 142
[33] 'Extract, uit het Register der Handelingen en Resolutien van den Minister, voor het Publieke Onderwijs, de Nationale Nijverheid en de Kolonien', No 3, 31 December 1820, cited in Gijzen 1938, 17

belong to the realm of natural history, but to that of comparative anatomy. Their home was the Anatomical Cabinet, at least until around 1860. At this point, curator Hidde Halbertsma used the Cabinet's move to rearrange and reclassify the preparations and to get rid of the preparations he deemed irrelevant for medical research and teaching. Among other things, he disposed of part – but not all – of Brugmans' comparative anatomy preparations. They were moved to the Museum for Natural History, of which the collecting order had been legally enlarged in 1859.[34]

These days, the collection is distributed among various institutions. Three Leiden museums house most of the remaining preparations: the university's Anatomical Museum, Naturalis (the successor of the National Museum for Natural History), and Museum Boerhaave, a museum devoted to the history of science and medicine.[35] The segmentation of the collection started, as we have seen, quickly after its acquisition. Historian Hans de Jonge has condemned the governors' decisions:

> Due to mismanagement by the Leiden university governors, who had no idea what kind of collection they had acquired, the collection fell apart as early as 1820 … The governors made the tragic decision to divide the Brugmans collection between both institutions [Museum for Natural History and Anatomical Cabinet] … The governors did not understand that the division completely negated the fundamental principle of the collection, the comparison of skeletons and organ systems throughout the animal series right to man.[36]

De Jonge implies that the governors should have preserved the collection according to Brugmans' 'original' intentions. He interprets their failing to do so as born of ignorance. However, De Jonge does not take into account that the governors did not acquire the Brugmans collection because they wanted to preserve material heritage, but because they believed the professors could use the preparations for teaching and research. (That said, the governors were keen on using the anatomical collections, including Brugmans', as status symbols because of their connection to the past, as we will see in the chapter on governors.) The professors indeed could but their ideas on research and teaching differed from Brugmans'. They therefore required a reinterpretation of his collection. Splitting up the collection was part of this reinterpretation, and as such, it reflects not a lack of insight, but changing ideas on research and teaching. Brugmans' preparations were flexible enough to be adapted to these changing ideas, mainly because they – like all preparations – were made of what they represented. In the following sections I will discuss the reuse of Brugmans' preparations in three medical disciplines: physical anthropology, pathological anatomy and comparative anatomy. We will see how researchers extracted new information from the preparations and how the preparations remained relevant in medical research throughout the nineteenth century.

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[34] Van der Klaauw 1926, 12
[35] De Jonge 2001, 6
[36] De Jonge 2005, 197

Physical anthropology

Physical anthropology has been defined as the study of the similarities and differences between the bodies of groups of people.[37] It focuses mainly on differences in the structure of the body. Researchers used two ways to establish these differences: they measured and compared either the bones of the dead or the bodies of the living. The former is called craniology or craniometry; the latter, anthropometry. In the nineteenth century, both were tied to medicine. Their practitioners were usually trained as medical men and published in medical journals; the required collections were, at least in the early days, housed in medical institutions. Here, I focus on craniometry because this approach relied heavily on anatomical collections.

In the Netherlands, craniometry became a well-defined area of study in the middle of the nineteenth century. Until 1900, Leiden was the field's main centre, with first the Anatomical Cabinet and then, from 1880 onwards, the Ethnographical Museum as the leading institution.[38] Leiden professors Teunis Zaaijer and Jan van der Hoeven belonged to the first practitioners. They were 'armchair anatomist-anthropologists'.[39] They did not go out into the field, but relied completely on the skulls and bones already present in their local collections. They used whatever materials came to them – either from overseas or from the past. In the early days in particular, they relied on older preparations: the Anatomical Cabinet received very few new anthropological preparations between 1835 and 1860.[40] Among these older preparations were the anthropological objects from the Brugmans collection.

As mentioned above, Brugmans collected foreign skulls on battle fields. He also received skulls (and other bones) from overseas through his connections in the military. How did he incorporate these objects in his collection? In 1817, Brugmans sent a description of his collection to the Leiden governors, as part of his offer to sell the collection. The description reveals that he had classified osteological preparations from foreign countries in a separate category, subdivision 14, which he described as follows:

> Changes in the normal condition and the resulting forms of the animal species. Especially of Man due to climate, way of life, etc. – This includes an extraordinarily rare and important series of approximately 120 human skulls from many different regions, all of them arranged according to their geographical locations, starting with the North Pole and ending with the Equator – Casts of faces of various nations are added to this, etc.[41]

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[37] I took most of the general information on physical anthropology in this section from Fenneke Sysling's overview of early Dutch physical anthropology (Sysling 2013, 1–84).

[38] Sysling 2013, 51–78. Around 1900, physical anthropology's momentum would move again, this time to Amsterdam – with the university's anatomical collections and the newly founded Colonial Institute (1910) as its loci.

[39] Sysling 2013, 23

[40] Teunis Zaaijer, 'Katalogus der ras-schedels, bekkens en skeletten in het Anatomisch Kabinet der Rijks-Universiteit te Leiden', 1893, Leiden, LUMC, archives Anatomisch Museum (no inventory number), p. 11. After 1860, import from overseas grew quickly. See Sysling 2013, 53–58.

[41] Brugmans to governors, 4 April 1817, AC2 70, 56

Brugmans was interested in 'changes in the normal condition' because these could help understand the way nature worked.[42] With regard to the taxonomy of men, Brugmans thought there existed one human race (consistent with his strong belief in the unity of nature), which could be divided in five sub-races, as had been argued by German researcher Johan Friederich Blumenbach.[43] Variations occurred due to external influences – 'climate, way of life, etc.'. Studying these variations would lead to a better understanding of how nature worked in 'normal' cases. Hence, to better understand the formation of the five sub-races, it was helpful to study skulls from different nations (and thus, influenced by different external factors). In Brugmans' days, studying skulls usually meant describing individual skulls and using these descriptions to uncover similarities and differences between 'races'.[44]

The physical anthropologists of the second half of the nineteenth century rejected the descriptive approach of Brugmans' time. Instead, they aimed to create a 'scientific' discipline. They believed conclusions should be based on a large number of precise, numerical measurements – a demand that fitted the rise of statistics and the emergence of the idea of scientific objectivity in that period.[45] The anthropologists built on Adoplhe Quetelet's idea of *l'homme moyen*, the average man. Quetelet, a Belgian astronomer, pioneered the use of statistical methods in the social sciences in the 1830s and 1840s.[46] He focused not on the individual and the particular, but on the whole and the average; a practice that was followed by researchers in many fields, including anthropology. The new 'scientific' approach forced the Leiden armchair anthropologists to get up, take up their measuring rods and reinvestigate the old Brugmans preparations.[47] Brugmans' labels and Sandifort's descriptions alone did not suffice.

Jan van der Hoeven was among the first Leiden researchers to apply quantitative methods to Brugmans' preparations. In 1842 he published his book *Bijdragen tot de natuurlijke geschiedenis van den Negerstam* ['Contributions to the Natural History of the Negro Race']. The natural history of the human race, Van der Hoeven explained, was part of the larger science of anthropology. Its two main areas of research were the differences between man and the other animals and the differences among men, in particular between the different human races. Van der Hoeven focused on the latter. He thought comparing the skulls of different races would prove particularly useful.[48] Therefore, his book contained a comparison of 'Negro' and 'European' skulls. The comparison was quantitative and based

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[42] Brugmans to governors, 4 April 1817, AC2 70, 56
[43] De Jonge 2001, 22; De Jonge 1999, 41–44
[44] Sysling 2013, 14–15
[45] Sysling 2013, 16. On the rise of statistics in general see Porter 1986. On the rise of statistics in Dutch medicine see Klep and Kruithof 2008. On scientific objectivity, see Daston and Galison 2007.
[46] Vanpaemel 2002
[47] Elshout claims that Brugmans measured his skull preparations, but it is unclear what her source is (Elshout 1952, 107). She refers to a catalogue on racial skulls by Sandifort (Sandifort 1838–1843), which does indeed contain some measurements of some Brugmans' skulls, but Sandifort nowhere writes that Brugmans himself made this measurements. It seems more likely that Sandifort did this – especially because the measurements are lacking in the earlier-published *Museum Anatomicum* (Sandifort 1827, 1835).
[48] Van der Hoeven 1842, 5

on averages, not individual cases: measurements and statistics, the foundations of nineteenth-century physical anthropology. The average dimensions of the 'Negro skulls 'resulted from a detailed investigation of ten skulls from the Anatomical Cabinet, all of them part of the Brugmans collection. Van der Hoeven admitted that ten was a small number and perhaps not enough to yield significant results.[49] He explained why he decided to publish his findings anyway: he hoped his first results would stimulate other people to collect measurements as well.

Van der Hoeven had carefully measured all ten Brugmans skulls, even though he had already published measurements of some of them before.[50] His new measurements had yielded more accurate numbers, something he considered important. He presented his results in a table.[51] For each skull, he provided twelve different dimensions, including the height and length of the skull, the width of the occipital hole, and the largest distance between the zygomatic arches. He subsequently took the averages of these dimensions and compared them to averages of dimensions of European and Chinese skulls. He defended his method as follows:

> We partly agree with those who think that this average measure is something imaginary. But it is imaginary in the same sense as the average temperature, the average barometric pressure, etc. are. And meanwhile, the physicists will not give up these imaginary things; [because] they have learned too many fine and useful things from them. I hope that in natural history of man we will follow our scientific friends in this regard. For more on such research methods, I refer to the penetrating writings of Quetelet.[52]

He stressed the value of averaging and he invoked Quetelet to strengthen his claim – in other words, he was a typical 'scientific' anthropologist.

Van der Hoeven was a professor of natural history at the faculty of natural sciences. The Anatomical Cabinet was part of the medical faculty and was managed by the professor of anatomy. How did Van der Hoeven gain access to the Brugmans skulls? In his book on the 'Negro race', he wrote:

> The Negro skulls which I have examined for this piece all belong to the collection of Professor Brugmans, which is now in Leiden University's museum of anatomy. The highly-learned Mr Sandifort opened this collection for my research with a willingness for which I want to thank him publicly.[53]

Van der Hoeven thanked Gerard Sandifort for his cooperation. As a curator of the Anatomical Cabinet, Sandifort had to follow the regulations outlined in the 1815 Royal Decree on Higher Education (RDHE). The decree prescribed in detail which professor was

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[49] Van der Hoeven 1842, 25
[50] Van der Hoeven 1842, 'Voorberigt' (unnumbered page)
[51] Van der Hoeven 1842, 30
[52] Van der Hoeven 1842, 36–37
[53] Van der Hoeven 1842, 26. Other institutional collections, both inside and outside Leiden, were used in research as well. See for example Swaving 1861, 285 (a skull from the *Bataafsch Genootschap*, Batavian Society).

in charge of which collection. For the Anatomical Cabinet, the anatomy professor was appointed.[54] Other professors could borrow objects from the collections for teaching and research purposes with the permission of the managing professor.[55] The RDHE regulations regarding collections were replaced in 1879, when a new decree governing the management and use of 'collections, institutions and teaching aids' in higher education was issued.[56] Again, borrowing objects from the collections was explicitly allowed, as was removing them from the buildings they were kept in, with the prior consent of the responsible official.[57]

Researchers not only had access to institutional collections, but also to private collections. The 1862 dissertation of Teunis Zaaijer offers an example.[58] Zaaijer examined two female East-Indian pelvises from the collection of the academic hospital. He compared them with five other pelvises. Four of these belonged to the collection of Amsterdam anatomist Willem Vrolik, who had sent them from Amsterdam to Leiden at the request of Zaaijer's supervising professor, Abraham Simon Thomas.[59] Apparently, collectors were willing to send preparations to other cities to facilitate research.

The fifth comparative preparation Zaaijer used came from the Anatomical Cabinet. It belonged to the Brugmans collection. Sandifort described it in the *Museum Anatomicum*, the Cabinet's catalogue, as 'pelvis of an adult Javanese woman, the bones artificially connected'.[60] He most likely based his description on a label or an inscription written by Brugmans, for it is unlikely he would have connected the preparation to Java if he had encountered the pelvis without any description. According to the present-day database of the Anatomical Museum, the pelvis bears the following inscription: 'pelvis feminae adultae javanensis' (pelvis of an adult Javanese woman).[61] This might very well be Brugmans' own inscription. Sandifort's modified description of the Javanese pelvis was further extended by Zaaijer. He explained that the bones were held together with metal wire (copper, according to the present-day database). More importantly, just like Van der Hoeven did with the skulls, Zaaijer introduced a quantitative description of the pelvis: he measured twenty dimensions, including the depth of the pelvis at its sides, the width of the pubic arc and the length of the sacrum. He did the same with the other pelvises he examined and, again like Van der Hoeven, he compiled his results into a table to facilitate comparisons.[62]

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[54] RDHE 1815, art. 178
[55] RDHE 1815, art. 200
[56] Reg. 1879
[57] Reg. 1879, art. 6 and art. 7
[58] Another example can be found in Hidde Halbertsma's article on the third joint on the occipital bone – Halbertsma used skulls from the private collections of both Van der Hoeven and Cornelis Swaving. (Halbertsma 1865, 222) Swaving himself used skulls from other private collections in his work, see for example Swaving 1861, 278.
[59] Zaaijer 1862, 11
[60] Sandifort 1827, 109 (object 1860). The Latin reads: 'Pelvis ossa artificialiter nexa foeminae [*sic*] adultae javanensis'.
[61] In the database, the preparation can be found as number Af0168.
[62] Zaaijer 1862, table after p. 30

The reinterpretation of Brugmans' anthropological preparations did not stop with Van der Hoeven and Zaaijer. Although new colonial skulls arrived in large numbers from the 1860s onwards, researchers continued to use skulls from the Brugmans collection. An example of this can be found in the 1877 dissertation of Pieter Koning, one of Zaaijer's students. Koning examined Chinese skulls, and although the majority of the sixty-seven skulls he measured had been acquired in recent years, he also used older skulls, including two from the Brugmans collection.[63]

All anatomist-anthropologists working on the Brugmans skulls extracted new information from them. Or, in Rheinberger's terms: they moved back from the epistemologicum, the stabilized object, to the original object of inquiry. This was easy because the skulls were made of what they represented. With other epistemologica, the epistemic recall would have been more troublesome: for instance, it would not have been possible if they would have had recourse to the drawings of the skulls only, such as those published in the fourth volume of the *Museum Anatomicum*. However, many of the measurements would have been possible with plaster casts. Although these are not made of what they represent, they have all of the necessary information (in this particular instance and in aid of this particular quantitative research question). In the next section, on pathological anatomy, we will encounter different types of reinterpretations, which neither drawings nor three-dimensional models would have allowed.

Pathological anatomy

In 1855, Leiden professor Hidde Halbertsma published a treatise on the pathological anatomy of teeth.[64] In his research, he used at least ten dental preparations from the Brugmans collection. He described them microscopically – something he could do only after partly dissecting the preparations, as he explicitly acknowledged:

> In a few very limited places, the structure of these globes [the *globuli dentis*, thought to be involved in the production of dentine, a component of teeth] presents itself differently than it does in by far the biggest part of the cross section *from which I have ground microscopic slides*.[65] (my italics)

Halbertsma depicted and described what he saw through his microscope – and, in doing so, reinterpreted a macroscopic pathological preparation on a microscopic level. This practice was not unusual in the mid nineteenth century and was caused by a shift in pathological theories.

Until the 1750s medics largely understood disease in terms of Hippocratic interpretations of the movement of fluids through the body. Various theories abounded, but all of them highlighted the build-up and balance of bodily fluids. Moreover, disease was

[63] Koning 1877, 6–7
[64] Halbertsma 1855
[65] Halbertsma 1855, 14

understood holistically, affecting the body as a whole. This changed when a new idea of disease arose: disease as a *localized* entity, caused by changes in a specific body part. Italian anatomist Giovanni Battista Morgagni advocated this new view early on. In 1761, two years before Brugmans was born, Morgagni published his magnum opus: *De sedibus et causis morborum per anatomen indagatis* [*The Seats and Causes of Diseases, Investigated by Anatomy*]. Soon after, the localized view of disease became widely accepted and Brugmans adopted it as well. Take, for example, his ideas on cancer, summarized by Abraham Capadose in his 1825 eulogy:

> [Brugmans'] explanation of the origin of cancers also belongs to the propositions with which Brugmans tried so vigorously to refute the principles of so-called humoralists; he understood them [cancers] not as already present in the blood before the vessel system was reached (as was still claimed by the learned Van Gesscher and many distinguished medical men), but as preceded by a peculiar change in the vessels and other solid parts.[66]

According the Brugmans, the cause of cancer was not to be found in one of the humours (here: blood), but in a specific body part: the vessels (or another solid body part, depending on the type of cancer). Note that humoralists did not deny that vessels were affected in the case of cancer. But they interpreted the damage as a *consequence* of the disease, not as its *cause*. In their eyes, the cause was to be found in the humours. As a result, the diseased body part, as a mere consequence, was not their first concern.[67] In the eyes of Brugmans and other followers of Morgagni, to understand disease one had to study its loci: the diseased body parts. These body parts could be found in pathological collections – a new phenomenon. Until then, anatomists primarily collected preparations of the normal (or even the perfect) body. Malformed and diseased body parts were collected from time to time, but mainly as a contrast to the healthy body, not because they were considered interesting in themselves.[68] With the localized view of disease, researchers required preparations of pathological body parts – the question now was: which body parts , and how should they be described?

For Morgagni, disease was primarily localized in *organs*. In the nineteenth century, however, the loci of disease would become even smaller.[69] In the early nineteenth century, following the work of the Frenchman Xavier Bichat, pathologists shifted their focus from organs to *tissues*. Soon after, in the 1830s and 1840s, the microscope became popular in medicine, leading to a cellular approach to pathology in the second half of the nineteenth century. Researchers now localized disease in *cells*; and they described it microscopically.

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[66] Capadose 1825, 602. Unfortunately, we have to rely on Capadose's report of Brugmans' ideas in this area, because Brugmans himself, again, did not publish them.
[67] Note that many different kinds of humoralists existed – most of them with more complex ideas on disease than Capadose suggests in his eulogy. He tends to oversimplify the view of the humoralists in order to sharpen the contrast between them and Brugmans.
[68] On the changing position of pathological preparations in the Leiden collections, see Hendriksen 2012, 105–134.
[69] On the development of pathology in the nineteenth century, see Maulitz 2002.

The changing loci did not end the need for pathological collections.[70] After all, diseases were still linked to specific body parts. Furthermore, we should understand the shifts to smaller loci not so much as replacements but as additions; the 'larger' seats remained important as well, but they were supplemented by descriptions on 'smaller' levels.[71] Hence, older, macroscopic preparations still had their use, but they had to be supplemented by microscopic preparations and descriptions of the same diseases. Often, existing preparations were used for conducting microscopic research because it took a lot of time and effort to build a pathological collection from scratch (there are many diseases, and most bodies, which were scarce already, tend to display only one of them).

The microscopic reinterpretation of macroscopic preparations was, of course, not limited to Leiden. The nineteenth-century pathological catalogues of the London Royal College of Surgeons, for example, mention the microscopic re-examination of older preparations,[72] as do the annual reports by the college's museum curator, for example from 1890–91:

> Advantage has been taken of the opportunity presented by the re-mounting of many old preparations to make microscopic sections of all growths not previously examined.[73]

Here, we do not know what 'old' means, but an early twentieth-century case at the college shows that such reinterpretation was done even with preparations made 150 years earlier. In 1909, curator Arthur Keith received, as he put it, 'permission to cut Hunterian free martin [*sic*] specimens'.[74] A freemartin is a specific type of hermaphrodite: the female calf of a mixed cow twin. John Hunter studied the freemartin in the late eighteenth century.[75] In the early twentieth, Keith wanted to revisit Hunter's freemartin preparations. Hunter had based his ideas mainly on external investigations of the preparation, but Keith wanted to investigate them microscopically and describe them on a cellular level.[76] Afterwards, he reported back to the Hunterian Trustees (who had granted him permission):

> The specimens you have given me the privilege of examining have been preserved – some of them at least – for over 140 years. It is not necessary to allude to the advantage of being able to verify and augment observations made after so long an interval. The state of preservation of the specimens is so good that there is every reason to believe that some future investigator, in the light of further progress in our knowledge, may still be able to glean fresh information from a re-examination of these specimens.[77]

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[70] On pathological collections in the nineteenth century, see Alberti 2011.
[71] Maulitz 2009, 369
[72] See for example Paget 1885, preface and individual object descriptions (e.g. number 3589, p. 29).
[73] 'Annual report of the conservator to the museum committee', 29 June 1891, p.2, RCSE RCS-MUS/8/2/2
[74] Arthur Keith Journals, Vol.1, 1908–09, RCSE MS0018/3/1/3, 4, 9 February 1909
[75] Hunter 1786, 46–62
[76] Minutes of the Hunterian Trustees, 10 February 1909, RCSE RCS-MUS/1/1/3
[77] Minutes of the Hunterian Trustees, 10 November 1909, RCSE RCS-MUS/1/1/3

Keith's investigation was by no means the first time Hunterian preparations were re-examined; it happened throughout the nineteenth century in order to update catalogue descriptions, and often this re-examination required redissection.[78]

Nineteenth-century researchers were not afraid to cut into old preparations, even if these had been made by famous anatomists like John Hunter.[79] Or by Sebald Justinus Brugmans, for that matter – as is evident from Halbertsma's research on teeth. And Halbertsma was not alone in dissecting Brugmans' preparations: Jan Nicolaas Bogtstra and Johannes Boogaard did so as well, about a decade after Halbertsma's work on teeth. They researched a malformation of the skull, for which they used several skulls from the Anatomical Cabinet. Boogaard, Bogtstra's supervisor, wrote an article about this, in which he stated:

> Dr Bogtstra described five skulls from the Leiden University Anatomical Cabinet [in his dissertation]. All of these skulls were sawn through vertically, close to the median plane, in order to simplify the investigation.[80]

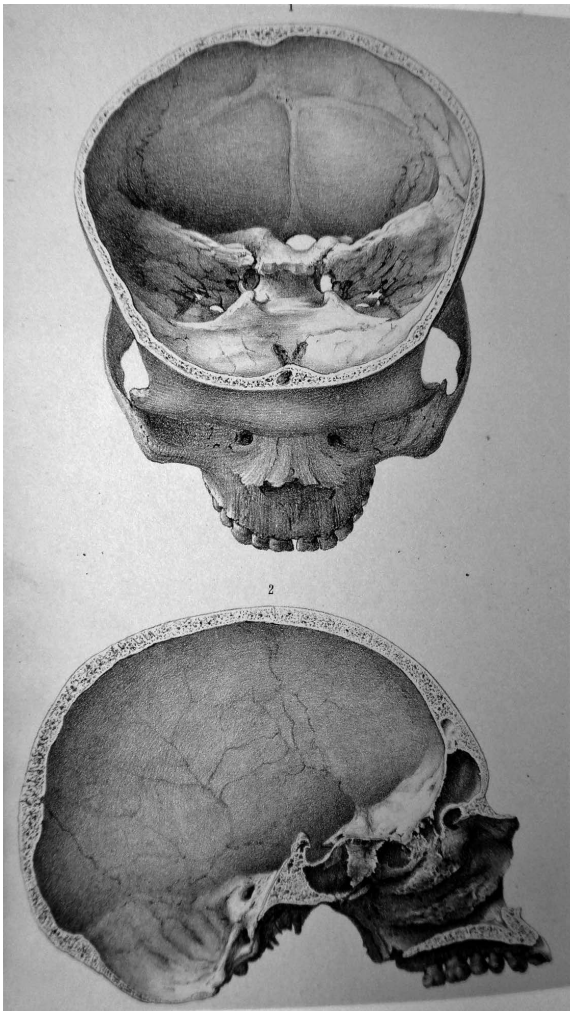

Figure 6. Skull from the Brugmans collection depicted in Jan Bogtstra's dissertation (1864).

[78] See for example Cobbold 1866, p. iv.
[79] Note that Arthur Keith, in the end, reported to the Trustees that he had managed to re-examine the Hunterian free martin preparations without damaging them (Minutes Hunterian Trustees, 10 November 1909, RCSE RCS-MUS/1/1/3) – usually, this was not the case when preparations were reinterpreted microscopically.
[80] Boogaard 1865, 86

Of the five skulls referred to here, two were from the Brugmans collection.[81] At least one of these was sawn through not once, but twice. This follows from figure 6, which displays an illustration from Bogtstra's dissertation, later reprinted in Boogaard's article. The skull depicted above and below is the same, according to the caption.[82] It was the skull of a Spanish man, collected by Brugmans. The illustrations were made by Leiden illustrator Hoffmeister, who constructed them according to photographs made of the skulls. The drawings show that Bogtstra and Boogaard must have sawn through the skull both vertically and horizontally – otherwise Hoffmeister would not have been able to draw both sections. Note that he still had to combine two photographs for at least one of the illustrations. If the skull had been sawn through vertically first, the photograph taken after that (of one of the resulting halves) could serve as basis for the illustration below. To subsequently create the figure above, it is necessary to saw both the left and the right half into two, take two photographs from the resulting lower quarts, and then combine them into one horizontal cross section.

The re-examinations described in this section are possible only with preparations, not with models or any other epistemologicum. The other epistemologica lack the required information (usually: the microscopic structure) necessary for reinterpreting because they are not made of what they represent. Preparations are, which makes them remarkably flexible. This flexibility enabled them to remain useful in medical research for a long time, but it had a downside as well: it limited the availability of preparations for *other* users – including researchers outside the medical faculty, as we will see in the next section.

Comparative anatomy

As mentioned above, even after Halbertsma's clean-up in the 1860s, the Anatomical Cabinet still contained animal preparations from the Brugmans collection. This might seem surprising given that Halbertsma only kept the preparations he deemed useful for research and teaching. Why, one might wonder, would *animal* preparations be of use when learning about *human* medicine? Before answering this question I will first give an example of how medical professors used the comparative anatomy preparations from the Brugmans collection in their research just like they used the pathological and the anthropological ones.

Halbertsma himself provides one such an example. In 1864, he wanted to prove that 'abnormal hermaphroditism' existed among fish.[83] According to Halbertsma, abnormal hermaphroditism involved hermaphroditism without the possibility of self-fertilization. He proved his claim by describing instances of this abnormal hermaphroditism in several species. For one of the species – the bass – Halbertsma used a Brugmans preparation to

[81] Bogtstra 1864, 10–11. After Bogtstra had finished his dissertation, Boogaard found three more skulls with the same malformation, which he also re-examined. All three of them belonged to the Brugmans collection. (Boogaard 1865, 92–93)
[82] Bogtstra 1864, 37
[83] Halbertsma 1864

prove his point.[84] He included an illustration of it (see figure 7). The drawing shows four of the fish's internal organs: the soft roe, the hard roe, the intestinal canal, and the straight intestine. Halbertsma explained that the liver was not visible in the illustration because it was located behind the bowels and the abdominal wall.[85] However, when he argued that this preparation was an example of abnormal hermaphroditism, he also wrote about the bass's liver, calling it a 'very easily recognizable liver'.[86] This would suggest that he could see it. But if the liver was hidden from normal view, as the illustration shows, it implies that Halbertsma opened the jar and took out the fish to pull away either the bowels or the abdominal wall so he could see the liver. Furthermore, he offered precise measurements of the organs, which would have been difficult had the preparation remained safely in the jar.[87]

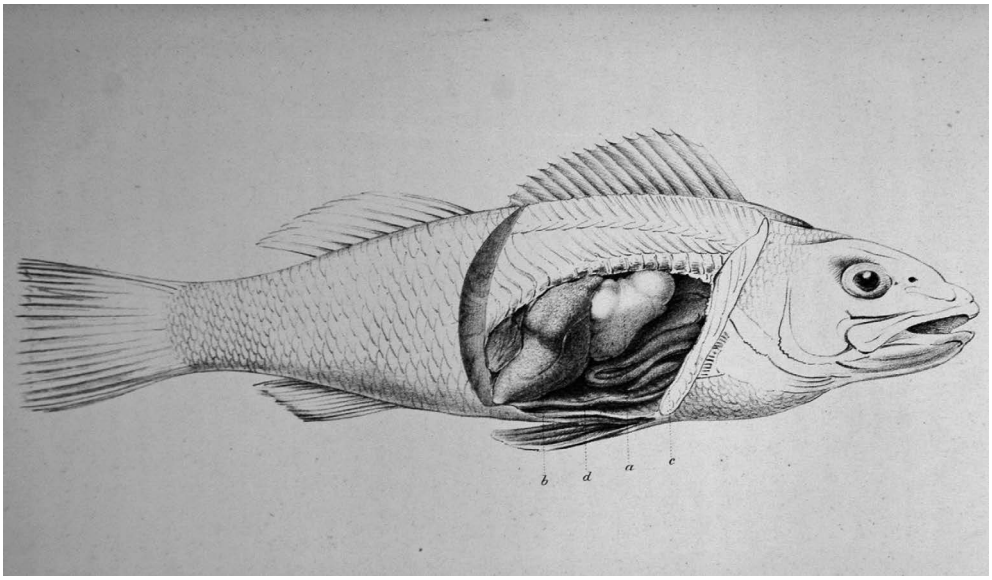

Figure 7. Wet preparation of a bass from Brugmans' collection reused by Halbertsma in his article on hermaphroditism.

Animal preparations were kept and (re)used in other medical institutions as well. All Dutch universities had comparative anatomical preparations in their medical collections, as they were required to according to the 1815 Decree on Higher Education.[88] Medical institutions in other European countries owned animal preparations as well: the Royal College of Surgeons in London, for example; the medical faculty at the University of

[84] Halbertsma 1864, 173–175. The preparation was listed in the Sandifort 1827, 31; object number 395 of '*Pars prior*' of the *Brugmansiana*. The present-day catalogue number is Af0055.
[85] Halbertsma 1864, 178
[86] Halbertsma 1864, 174
[87] Halbertsma 1864, 173–174
[88] RDHE 1815, art 177

Vienna (where the proper location of the collections was a matter of fierce debate); and the medical faculty at the University of Berlin. In nineteenth-century Europe, all significant medical collections kept animal objects alongside human preparations.[89]

Comparing the anatomical structures of different animals was a regular method used to answer questions about human anatomy and physiology in the nineteenth century.[90] This method was not new; it was common in the early modern period as well. In fact, it was the main reason Brugmans offered for building his comparative anatomy collection. In 1807, he explained the ideas behind his collection in a memorandum:

> The undersigned [Brugmans] [has] devoted himself to building, with high costs and much work, a rather extensive collection for the benefit of his classes in natural history, in particular the ones on comparative anatomy; in order to be able to substitute to a certain extent, in 2 or 3 branches of science, for what is missing in the academic collection, so as not to keep his audience ignorant of the advances that were made in the natural history in particular as subsidiary science to the anatomy and physiology of man, by so many famous men all over Europe in the last few years.[91]

Brugmans stated he had built his collection in particular for his classes in comparative anatomy. In these classes, he wanted to focus on these developments of natural history (of which he considered comparative anatomy to be part) that assisted the anatomy and physiology of man. In other words, his collection was primarily intended not to understand animals, but to teach medical students about the human body. I would therefore refer to Brugmans' comparative anatomy as a 'medical' comparative anatomy.

Until around 1800, this was the only kind of comparative anatomy around.[92] However, in the early nineteenth century, Georges Cuvier (1769–1832) almost single-handedly introduced a new kind: 'zoological' comparative anatomy.[93] Like medical comparative anatomy, zoological comparative anatomy had as its main method the

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[89] For the composition of the College's collection, see its many nineteenth-century catalogues (e.g. RCS 1833–1840); on its animal preparations, see also Jacyna 1983 and Desmond 1989 – although both of them seem to consider them an anomaly, and not a common feature of medical collections at the time; a recurring problem in the historiography of nineteenth-century anatomical collections. On animal preparations in British medical collections in general, see Alberti 2011, 57. On comparative anatomy in Vienna, see Buklijas 2005, 146–151. On the collections in Berlin (including that of Rudolf Virchow), see Matyssek 2002, 53; and Virchow 1901 (reprinted in Matyssek 2002, 141−158), in particular the included floor plan of the university's new pathological museum. On animal preparations in German medical collections see also Nyhart 1995.

[90] In her book on the study of form in nineteenth-century Germany, Lynn Nyhart has shown how morphology – a combination of comparative anatomy, embryology and histology – was part of both the medical and the zoological faculties at the German university. She argues that morphology's position within the German medical faculties changed: the new physicalist physiologists disapproved of morphology; the field then found a new home in the anatomy departments. (Nyhart 1995) Laurens de Rooy has shown that Dutch anatomists also embraced the study of animal structure in the nineteenth century. He argues that Dutch anatomy used evolutionary morphology, of which comparative anatomy was part, to escape from the crisis that had hit the discipline in the 1860s. (De Rooy 2011)

[91] Brugmans, 3 March 1807, in a memorandum attached to the report 'Verslag van den Senaat aan Curatoren over het aantal studenten en het gegeven onderwijs' (13 March 1807), cited in Molhuysen 1924, 90*

[92] On this kind of comparative anatomy in the eighteenth century, and in particular on why it cannot be considered an independent discipline, see Cunningham 2010, 295–359.

[93] A helpful introduction to Cuvier's ideas is Farber 2000, 37–45.

comparison of animal structures. However, its aim was different: it did not try to answer research questions on human anatomy and physiology. Instead it focused on zoological questions; in particular, it aimed to discover the laws of animal organization.

Natural history professor Jan van der Hoeven, whose work on 'Negro skulls' has already been discussed, was a practitioner of this new, zoological comparative anatomy. At least, he tried to be – but several obstacles prohibited him from practicing this new discipline as he wanted. A year before his death, he wrote:

> As early as 1829 I pressed the university governors to establish a cabinet of comparative anatomy; I continued to do so until 1861, when I was treated in a way that made me cease my efforts once and for all. I set great store by a collection of comparative anatomy, but even greater store by my independence, and I'd rather abandon my favourite idea than desperately beg for something that science can claim legitimately.[94]

The quotation reveals the main obstacle Van der Hoeven encountered: he lacked a comparative anatomy collection. (It also reveals that the relationship between Van der Hoeven and the university governors was tense to say the least – they continuously refused his requests and finally, in 1861, relocated part of the Brugmans preparations without consulting him.) Like pathological anatomy and physical anthropology, comparative anatomy (whether zoological or medical) was a collection-based research area.[95] If Van der Hoeven wanted to practice it, he needed access to a proper collection. The only comparative anatomy collection present in Leiden at the time (Van der Hoeven was a professor from 1826 to 1868) was the Brugmans collection, which was still largely housed in the Anatomical Cabinet. The anthropological collection was also located in the Cabinet and, as we have seen, Van der Hoeven could easily use preparations from this collection. So what was the problem with the comparative anatomy collection? Could Van der Hoeven not have done the same – simply borrow the preparations he needed? The answer is no. Van der Hoeven was trying achieve something different: instead of answering research questions (as with his anthropological work), he aimed to establish an independent research field – a new discipline, one might say.

Van der Hoeven's ambition to establish (zoological) comparative anatomy as an independent area of study was clearly expressed in his 1867 article 'Over den aard en het doel der vergelijkende ontleedkunde, en over hare hulpmiddelen te Leiden' ['On the Nature and the Purpose of Comparative Anatomy, and on its Resources in Leiden'].[96] In the opening paragraph, he announced his intention to increase comparative anatomy's reputation in the Netherlands, which, so he stated, is sadly wanting.[97] He also repeatedly stressed that comparative anatomy needed to be independent of medicine. His ambition also follows from his attempts to recruit practitioners. No discipline without practitioners,

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[94] Van der Hoeven 1867, 664
[95] Pickstone 1994, 117
[96] Van der Hoeven 1867
[97] Van der Hoeven 1867, 657

and Van der Hoeven hoped to create them by tempting medical students into comparative anatomy, as he revealed in his letter to Collot d'Escury:

> It is bound to work; the zeal of many for this field of study [natural history based on comparative anatomy] will be aroused and the science will attract more and more practitioners.[98]

Collections are useful tools in discipline formation. Frances Larson has shown how the acquisition of the Pitt Rivers collection laid the foundations for the discipline of anthropology at Oxford University.[99] The collection visibly demarcated the boundaries of the young discipline.[100] Furthermore, the presence of the collection forced the university's administrators to allocate funds to anthropology: they could not let the prestigious collection deteriorate. An independent comparative anatomy collection, managed by Jan van der Hoeven, could have improved the position of comparative anatomy in Leiden in a similar way. It would have provided Van der Hoeven with some financial backing from the administrators as well as a collection space, which could have been used for research. Furthermore, the collection in itself, with its thousands of preparations would have been a strong, visible presence of the discipline. Once big enough, a collection can gain a kind of momentum that turns it into a self-fulfilling prophecy. Cuvier employed his comparative anatomy collection in this way. He admitted: 'I succeeded in making my collection so important that soon nobody dared to oppose its further enlargement.'[101]

Van der Hoeven wanted a collection to establish comparative anatomy as an independent field of study. While the Brugmans collection contained over two thousand comparative anatomy preparations, it could not fulfil this role. There were two problems. The first, which related to the collection's contents, could have been overcome, had it not been for the second: the prolonged use of the collection in the medical faculty.

Let us look at the contents first. Brugmans built his collection in aid of his medical teaching. How did this intention materialize in his collection? Which animal structures are needed to learn about the human body? According to Brugmans, and almost everyone else, structures of the animals closest to humans: the vertebrates. Within the vertebrates, mammals were considered the most useful. Indeed, in Brugmans' collection, vertebrates in general and mammals in particular are best represented. Almost all of the comparative anatomy preparations involve vertebrates, with only 71 invertebrates.[102] Moreover, more than half of all objects stem from mammals (1198), of which almost a third are human preparations. This made the collection useful in medical teaching, as was happily acknowledged by medical professor Gerard Sandifort:

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[98] Van der Hoeven to Collot d'Escury, 21 January 1829, AC2 607E
[99] Larson 2008
[100] On collections as tools in boundary work see also Whitehead 2009; Alberti 2009b.
[101] Flourens 1856, 183; translation taken from Outram 1984, 176. On Cuvier's use of his collection to make comparative anatomy visible, see Outram 1984, 175–180
[102] Van der Klaauw 1930, 52

> If one takes a look at the sketch outline of this collection, drawn up by the late professor Brugmans himself … it will soon become clear … that from the very beginning the intention behind the collection was to gain more knowledge about the structure and the actions of the human body, and all of professor Brugmans' classes on comparative anatomy also had this intention … In the present-day state of this science [physiology] it is not possible to explain the various functions of the parts of the human body without resorting to comparative anatomy, it being the rich resource for physiological knowledge of the human body.[103]

Van der Hoeven, on the other hand, was not all that happy about the composition of the Brugmans collection. In his eyes, a comparative anatomy collection aimed at medical teaching could never suffice when teaching of the new and 'real' comparative anatomy. He argued that a professor in zoology and comparative anatomy could not be expected to make do with the medical faculty's comparative anatomy collection, just a chemistry professor could not be expected to borrow the preparations he needed from the professor in materia medica.[104] In his letter to governor Collot d'Escury, Van der Hoeven referred to the difference between both types of collections:

> a collection of comparative anatomy as appendage to a cabinet of human anatomy and physiology, no matter how excellent, never *could*, nor *should*, be arranged like a collection of comparative anatomy in explanation of zoology. The last, however much it is instrumental in general physiology because of the joint ties that connect all sciences, has to have an extensiveness which also has a completely independent tenor.[105]

Medical comparative anatomy collections required only preparations that would help answer questions about human anatomy and physiology. A zoological comparative anatomy collection needed much more. According to Van der Hoeven, the aim of zoological comparative anatomy was to formulate 'a theory of animal forms', that is, an explanation of why animals (including man) are built the way they are. This explanation could be achieved by comparing the structures of different animals, for this would result in a classification of 'all typical varieties'.[106] To formulate a theory of animal forms, comparative anatomists had to study *all* types of animals, not just the vertebrates. This was the 'extensiveness' Van der Hoeven referred to; an extensiveness that the Brugmans collection lacked due to its limited number of invertebrates.

Although the Brugmans collection itself was unsuitable for researching and teaching the new zoological comparative anatomy, it could have been a foundation for a collection that was suitable. And Van der Hoeven wanted it to be, as he made clear in his continuous requests for a separate comparative anatomy collection.[107] In 1859, for example, he proposed to merge the Brugmans collection (that is, the comparative anatomy part) with his

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[103] Sandifort to governors, 2 December 1819, AC2 72, 149. In the first sentence, Sandifort refers to the report Brugmans sent to the governors when he offered them his collection.
[104] Van der Hoeven to Collot d'Escury, 21 January 1829, AC2 607E
[105] Van der Hoeven to Collot d'Escury, 21 January 1829, AC2 607E
[106] Van der Hoeven 1867, 16
[107] On these requests, see Van der Klaauw 1926, 10–12 and De Jonge 2005, 185.

private collection. Together, the collections would form the starting point for an institutional comparative anatomy collection, which, in time, could be extended further. The governors refused all of his requests and Brugmans' preparations remained in the Anatomical Cabinet. That is, until 1861, when the governors transferred part of the comparative anatomy preparations from the Cabinet to the Museum for Natural History – all behind Van der Hoeven's back.[108] In the Museum the preparations were even harder to access for Van der Hoeven than in the Cabinet because of his fierce conflict with the museum director, Hermann Schlegel.[109] The governors' move proved too much for Van der Hoeven – he gave up his thirty-year quest for an independent comparative anatomy collection. During that quest, Van der Hoeven had never understood – or so he claimed – why the Brugmans preparations had been placed in the Cabinet to begin with. He called this 'inexplicable'.[110] But from our perspective, it seems quite simple. Eighteenth-century comparative anatomy preparations belonged in a nineteenth-century medical collection because animal preparations were widely used in nineteenth-century medicine and because old preparations, being made of what they represented, could easily be adapted to new research questions.

Van der Hoeven never established the independent comparative anatomy collection he desired. The Brugmans collection had the wrong composition, but that problem could have been overcome – if it had not been for the second problem: the collection's location in the Anatomical Cabinet. As long as the collection was housed in the Cabinet, Van der Hoeven could never exert the necessary influence to alter its contents. Nor could the collection play its required role of independent visible presence of the new research area, zoological comparative anatomy. Before Van der Hoeven could use the Brugmans collection to demarcate comparative anatomy, he had to gain control over it. He tried to do so, more than once, but failed. In the end, part of Brugmans' comparative anatomy preparations ended up in the Museum for Natural History; many remained in the medical faculty's Anatomical Cabinet throughout the nineteenth century. The Cabinet's curators, all medical professors, did not feel the need to dispose of them because they continued to be useful in medical research and teaching. Since they enabled reinterpretation quite well, the preparations could be adapted to changing practices and theories, not only in comparative anatomy, but, as we have seen, in other areas of study as well.

Conclusion

For nineteenth-century researchers, preparations were flexible objects. They are made of what they represent and thus enable, in Rheinberger's terms, epistemic recall. This helps to explain their prolonged use. But we should not forget that, although they are made of what

[108] Van der Klaauw 1926, 11–12
[109] More on the disturbed relations between Van der Hoeven and Schlegel in De Jonge 2005.
[110] Van der Hoeven 1867, 663

they represent, preparations are *made* nonetheless – preparations are *not* naturalia. And thus, their reinterpretation is not limitless.

Rheinberger points to reinterpretation's limits when he claims that epistemic recall is easier with herbarium plants than with macroscopic preparations because herbarium plants have been manipulated less.[111] It is undoubtedly true that macroscopic preparations contain a fair amount of manipulation: a kidney preparation is not *solely* made of kidney, but also contains materials like injection mass and preparation fluid, and a great deal of work. And indeed, this may complicate their reinterpretation. Part of the information present in the raw material inevitably gets lost in the making – or the keeping. Hidde Halbertsma discovered this when working on the hermaphrodite bass. Halbertsma was unable to complete his reinvestigation because the preparation fluid had affected the fish's organs:

> In our preparation, it could, to our regret, no longer be demonstrated how the seed was ejected, because the deeper-lying organs were in a softened condition and hence the probable *vas deferens* could no longer be detected.[112]

Present-day biologists also encounter such problems when attempting to extract DNA from (early twentieth-century) preparations stored in formaldehyde, which is much less DNA-friendly than alcohol.

The nineteenth-century afterlife of the Brugmans collection has shown that reinterpreting macroscopic preparations is very well possible – but it also has its limits. Yet, the possibilities were large enough to keep medical researchers using the Brugmans preparations throughout the century. This sometimes excluded researchers outside the medical faculty, as was the case with Jan van der Hoeven. It excluded other user groups as well, ones not involved in research practices: the lay visitors and the university governors – and it is to them that we now turn.

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[111] Rheinberger 2010, 238. Herbarium plants are one of the four types of preparations Rheinberger distinguishes. The other three are: anatomical preparations, microscopic preparations and chromatograms. Chromatograms reveal (and simultaneously *are*) the components of molecules; the most famous example are the DNA barcodes. They are iconic of twentieth-century molecular biology (and twenty-first-century crime shows), but of no concern to us here. 'Anatomical preparations' to Rheinberger are human or animal preparations visible to the naked eye. Note this differs slightly from my usage. For me, 'anatomical preparations' can include microscopic preparations as well; I use 'macroscopic preparations' to define the objects Rheinberger calls 'anatomical preparations'.
[112] Halbertsma 1864, 174–175